CHAPTER 1

INTRODUCTION

1.1 Background

Research and innovations of the prevention of gas explosion is always been developed by using advance technologies. The hydrogen gas production is continuously processed as the demand for its' usage growing rapidly. Hydrogen gas can be produced from steam reforming natural gas, and steam gasification process. It is widely used for producing ammonia for fertilizer, petroleum refining, glass purification and many others application. According to Fuel Cell & Hydrogen Energy Association's Fact Sheet, another uses of hydrogen is as a clean fuel for fuel cell electric vehicles (FCEVs).

In most industries, the hydrogen gas was transferred from one section to another section by using pipelines and hydrogen storage in a circular tank. However, one of the major problems occurred when applying hydrogen usage is the combustion and explosion accidents in industries (C. Tang et al., 2009). A Neville (2009) stated that an explosion cannot occur in a tank or closed vessel contains only hydrogen. Thus, an oxidizer such as oxygen and source of ignition must be present to start the explosion with hydrogen concentrations content range from 18.3% to 59% equivalence to flammability range from 4% to 74% in air (Xueling Liu, and Qi Zhang, 2014).

In the summer 1985 in Norway, a severe hydrogen-air explosion occurred in an ammonia plant. Bjerketvedt, D and Mjaavatten, A (2005) reported that the incident is one of the largest gas explosions in industrial hydrogen explosion. Three men were seriously injured and destruction of the building of the explosion occurred were resulted from the explosion. The source of the explosion was happened at pipe leakage at one of the operating pump that feeding water to a vessel containing hydrogen at a pressure of 30 bars. The pressure push the water flow to back flow and reach the leaking point. Hydrogen discharge at the leakage point lasted about 20 to 30 seconds before the explosion occur which also released 10 to 20 kg hydrogen gas. The incident causes a large horizontal jet flame for about 30 seconds.

Another hydrogen-air explosion incident occurred at China Light and Power Cast Peak Generating Station in August 28, 1992. The explosion happened in confined vessels which are two receivers that supply hydrogen to a generator. The plant was shut down on August 24 to 26 and resume to supply hydrogen to receivers on August 27. Suddenly the hydrogen purity in the generator dropped to 85% and the receivers were disconnected from generator for hydrogen purity sampling. The sampling shows the purity is 95% and then the two receivers were reconnected to supply hydrogen to generator. Again, the purity in the generator indicated 85% hydrogen purity. 20 minutes later, both receivers exploded at 10:05 a.m. which resulting two fatalities; 18 injured by fragments and the extensive blast damage in 100 m radius. An investigation from the incident reported that all the gas supplied to the receiver over 20 hour period was air. When hydrogen mixed with air at right concentration at 18.3% to 59%, explosion can be happen and this explained the cause of the explosion in the receivers.

Explosions are destructive phenomenon that could affect the economic implications and major social (M. Prodan et al, 2012). Therefore, it is necessary to know the explosion parameters and characteristic. A triangle explosion diagram simply explains the way on how an explosion occurred by three factors. The factors are oxygen concentration, fuel concentration, and source of ignition.

1.2 Motivation

Hydrogen gas usage, processing, and storing had been widely appeared in whole word. Hydrogen is a promising energy in the future and the demand of hydrogen gas will increases in the future. H. Xiao (2010) take the USA as an example, it was estimated that by 2040 the annual demand for hydrogen will reach 15 million tons. Rapid processing, transporting, and selling the hydrogen gas would result in applying for better technology to achieve the demand. But, lack information about hydrogen safety handling is the main reasons that initiate to the explosion. Thus this situation leads to the risk towards hydrogen explosion that could cause a serious accident in industries when no safety considerations are takes into account.

The safety practices in production, storage, distribution and use of hydrogen are key issues to hydrogen energy industrialization. In addition, this study can provide a basis for the development of preventive and control measures for explosion accidents of hydrogen and further study of gas activity.

1.3 Problem statement

Hydrogen explosion in air determines the explosion severity when explosion occurred in a vessel. When an explosion happened, the mass and energy content within the mixture mostly dominated by hydrogen as fuel are high enough to cause a massive explosion. Besides that, the explosion mechanism such as diffusivity, and flame structure encourage the explosion to reach the maximum parameter. Then, the resulting effect from the explosion is the rate of pressure rise and deflagration index which are two important measurements of explosion severity. Explosion characteristics study had been conducted through many researchers in various type of vessel shapes and dimensions.